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## EUROPEAN PATENT APPLICATION

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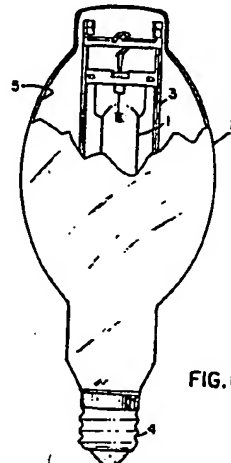
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⑤④ Long life, warm color metal halide arc discharge lamp.

⑤⑦ A warm color, long life metal halide arc discharge lamp employs a phosphor mixture on the interior surface of the outer jacket. The mixture comprises from 40-60% manganese activated magnesium fluorogermanate and 40-60% europium activated yttrium orthovanadate. The color temperature of the lamp is between 3200 - 3300°K and the C.R.I. is 74.9.



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## LONG LIFE, WARM COLOR METAL HALIDE ARC DISCHARGE LAMP

## TECHNICAL FIELD

This invention relates to metal halide arc discharge lamps and more particularly to such lamps which provide a warm color temperature approximating that of incandescent lamps.

## BACKGROUND ART

Metal halide arc discharge lamps comprise an arc tube containing mercury and a plurality of metal halides, usually the iodides of, for example, sodium and scandium, and a starting gas such as argon. These lamps are well known and are frequently employed in commercial establishments because of their long life (about 10,000 to 20,000 hours depending on wattage) and their high efficacy. The efficacy of lamps is usually measured in lumens/watt, and the metal halide arc lamps have efficacies in the neighborhood of 80 to 125 lumens/watt, again, depending on the wattage. In spite of all the favorable characteristics of these lamps, their use is sometimes contra-indicated where good color rendition is necessary because of their relatively high color temperature, i.e., over 4400° Kelvin (K). Changes in color temperature to lower values necessitates an increased ratio of red radiation to blue radiation without a significant change in green radiation.

Attempts, not altogether successful, to improve the color of visible radiation have included adding other metals, such as lithium iodide, to the arc stream, and phosphor coating the interior of the outer jacket that surrounds the arc tube. The latter technique has frequently been employed with high pressure mercury discharge lamps. (See, for example, U.S. Patent Nos. 3,825,792 and 4,241,276.) Phosphor coated metal halide lamps also are available but with color temperatures of only 4000° K.

Another recent attempt to lower the color temperature of such tubes involved increasing the arc tube loading. This raises the

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temperature of the arc tube wall which, in turn, increases the pressure obtainable in the gaseous phase, especially that of the sodium and mercury. The effect on the discharge is twofold. First, the core temperature decreases which reduces atomic mercury radiation creation and gives the lamp a lower color temperature. Second, the sodium is pressure broadened further into the red which further reduces the color temperature. However, penalties are suffered when the arc tube is too highly loaded. For example, such a lamp would have a loading of 20.7 watts/cm<sup>2</sup> whereas conventional metal halide lamps have a loading of 12.4 watts/cm<sup>2</sup>. The high loading apparently requires removing the lamp starting probe from the arc tube. This necessitates a costly external starting circuit employing a probe in close proximity to the arc tube. This condition potentially leads to sodium electrolysis through the arc tube wall. Additionally, the increased wall temperatures accelerate life limiting reactions of the additives with the arc tube wall. Such reactions can cause catastrophic failure within 4000 hours; an unacceptable condition.

#### DISCLOSURE OF THE INVENTION

It is, therefore, an object of this invention to obviate the disadvantages of the prior art.

It is another object of the invention to enhance metal halide arc discharge lamps.

Yet another object of the invention is the provision of a metal halide arc discharge lamp having a low color temperature and a long life.

These objects are accomplished, in one aspect of the invention, by the provision of a metal halide arc discharge lamp which comprises an arc tube mounted within an outer jacket. The inside surface of the outer jacket is coated with a mixture of phosphors which selectively absorb some of the blue and ultraviolet emission of the arc tube and re-emit this absorbed energy in the red region of the spectrum, thus shifting the color temperature from about 4600°K to between 3200°K - 3300°K. This useful shift in color

temperature is accomplished by this invention without any change in the standard arc tube, its fill or its loading, thus eliminating the problems occasioned by the prior art.

### BRIEF DESCRIPTION OF THE DRAWINGS

5        FIG. 1 is a diagrammatic view, partially in section, of a lamp employing the invention; and

FIG. 2 is a combined spectral distribution curve illustrating the spectra of an uncoated prior art lamp and the coated lamp of the invention.

### 10        BEST MODE FOR CARRYING OUT THE INVENTION

For a better understanding of the present invention, together with other and further objects, advantages and capabilities thereof, reference is made to the following disclosure and appended claims taken in conjunction with the above-described drawings.

15        Referring now to the drawings with greater particularity, the metal halide arc discharge lamp of FIG. 1 comprises a mercury containing arc tube 1 within a glass outer jacket 2. The arc tube 1 contains an inert starting gas, e.g., argon, and at least the halides of sodium and scandium. Generally, the halides are the  
20        iodides. The arc tube 1 is supported in the usual mount 3 and has the usual electrical connections to base 4.

The dotted line spectrum of FIG. 2 represents the light output of the arc tube 1, when operating. As can be seen therefrom the spectrum has strong peaks in the blue region but is relatively  
25        deficient in the red. Not shown in the spectrum is the strong peak in the ultraviolet (at 365 nm) which occurs from the mercury discharge. Such an arc tube, when operated in a clear glass BT37 jacket at 400 watts, has a light output of about 38410 lumens; a color temperature of about 4465°K; and a color rendering index  
30        (C.R.I.) of 63.0.

The lamp of the invention is formed by applying to the interior surface of jacket 2 a phosphor coating 5. The phosphor coating 5 comprises a mixture of a first phosphor which absorbs radiation in the blue region and emits in the red; and a second phosphor which  
5 absorbs radiation in the ultraviolet and also emits in the red. The mixture comprises from 40 weight percent to 60 weight percent of the first phosphor with the balance being the second phosphor. The preferred range is 50% of each phosphor.

In a preferred embodiment the first phosphor is a manganese  
10 activated magnesium fluorogermanate ( $\text{Mg}_4(\text{F})\text{GeO}_6 : \text{Mn}$ ) (Sylvania type 236 or 2361) and the second phosphor is europium activated yttrium orthovanadate ( $\text{YVO}_4 : \text{Eu}$ ) (Sylvania type 2390 or 2391). The preferred mixture includes 1.5 grams of each phosphor.

The spectrum of the lamp employing phosphor coating 5 is shown  
15 by the solid line in FIG. 2. The differences between the two spectra are clearly apparent and show the additional emission peaks in the red region (at about 620 nm and 658 nm) with a concurrent suppression of the blue emission. The overall result provides a lamp color temperature of about 3266°K and a marked improvement in  
20 color rendering with a C.R.I. of 74.9. There is a slight but tolerable drop in lumens to about 36820.

Thus, there is provided a metal halide arc discharge lamp having a desirable, low color temperature and high C.R.I. The result is accomplished without disturbing the complicated, but proven,  
25 chemistry of a conventional metal halide arc tube, and the typical life expectancies of such lamps are maintained.

While there have been shown and described what are at present considered to be the preferred embodiments of the invention, it will be apparent to those skilled in the art that various changes and  
30 modifications can be made herein without departing from the scope of the invention as defined by the appended claims.

## CLAIMS

1. A high pressure metal halide arc discharge lamp comprising:  
an arc tube containing therein an inert gas, mercury and at least  
the halide of sodium, said arc tube, when operating, providing a  
light output having a spectral response which includes radiation in  
the ultraviolet and blue regions of the optical spectrum but being  
substantially deficient in the red region of said spectrum, said  
light output of said arc tube having a color temperature of over  
4400°K; said arc tube being disposed within an outer jacket having a  
phosphor coating on the inner wall thereof; said phosphor coating  
comprising a mixture of a first phosphor which absorbs radiation in  
the blue region of said spectrum and emits radiation in the red  
region, and a second phosphor which absorbs radiation in the  
ultraviolet region of said spectrum and emits radiation in the red  
region; whereby the light emitted by said lamp has a color  
temperature of about 3200°K to 3300°K.
2. The lamp of Claim 1 wherein said first phosphor comprises  
about 40 weight percent to about 60 weight percent of said phosphor  
coating and the balance comprises said second phosphor.
3. The lamp of Claim 2 wherein said first phosphor comprises  
about 50 weight percent of said phosphor coating.
4. The lamp of Claim 2 or 3 wherein said first phosphor is  
manganese activated magnesium fluorogermanate and said second  
phosphor is europium activated yttrium orthovanadate.
5. The lamp of Claim 1, 2 or 3 wherein said arc tube includes  
the halide of scandium.

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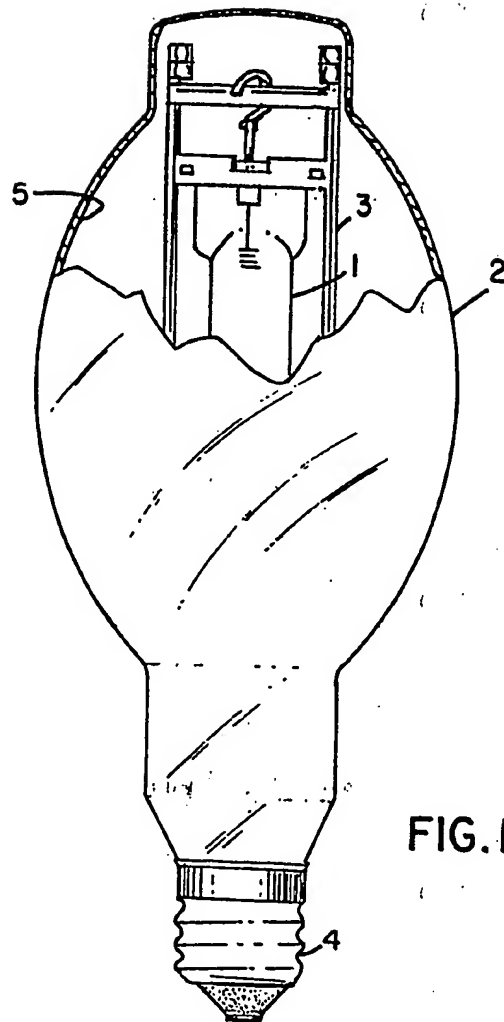
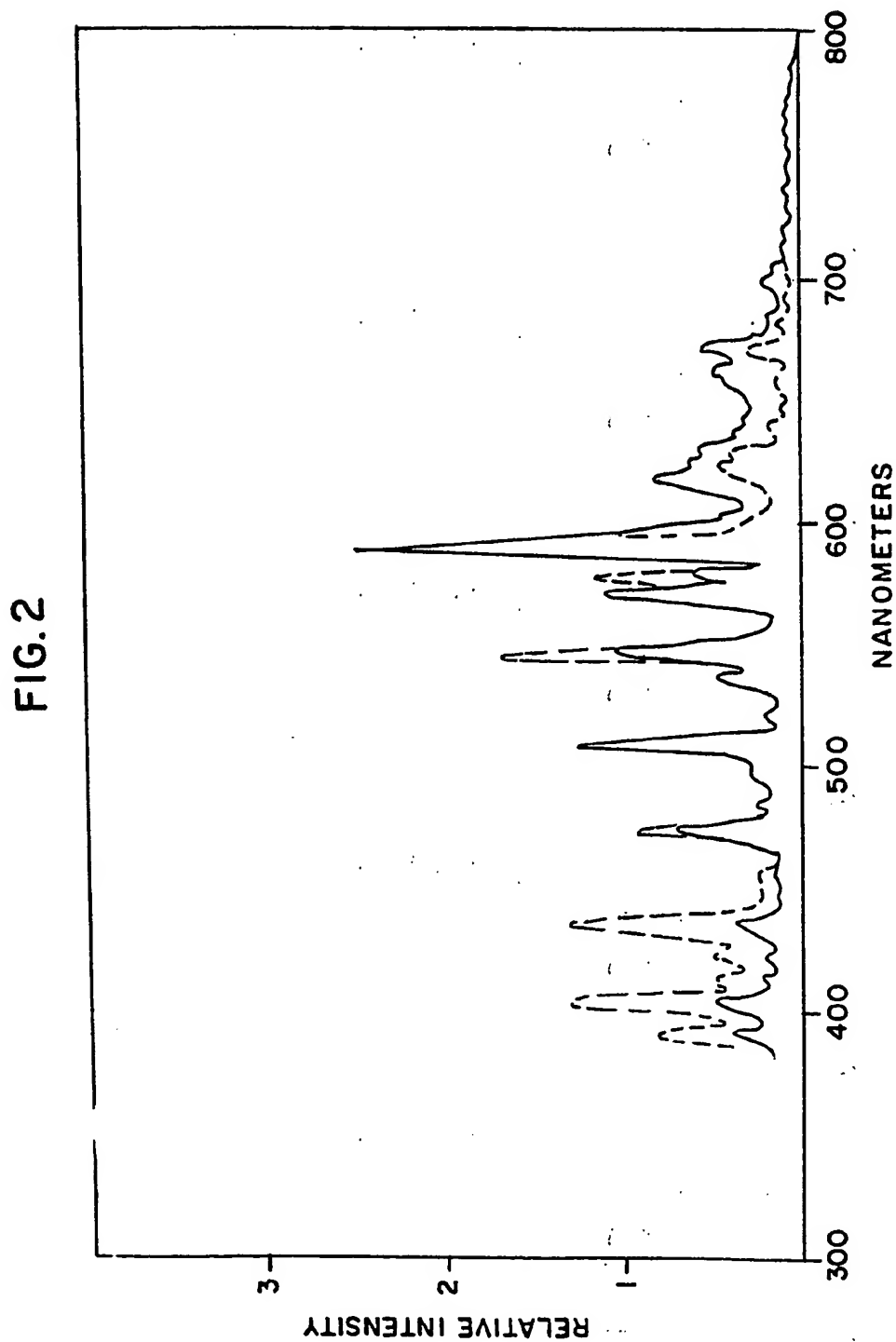


FIG. 1

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# EUROPEAN SEARCH REPORT

**0087745**  
Application number

EP 83 10 1743

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)
A	NL-A-7 920 189 (MITSUBISHI DENKI) * Claims 1-12 *	1-4	H 01 J 61/44
A	--- JAPANESE PATENTS REPORT, vol. 76, no. 1, week X01, Part I - Chemical, & JP - A - 75 039 629 (HITACHI LTD.) 18-12-1975 * Whole abstract *	1-4	
			TECHNICAL FIELDS SEARCHED (Int. Cl. 3)
			H 01 J
The present search report has been drawn up for all claims			
Place of search <b>THE HAGUE</b>		Date of completion of the search <b>31-05-1983</b>	Examiner <b>DROUOT M.C.</b>
<b>CATEGORY OF CITED DOCUMENTS</b>			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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